

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

ملخص

معمل البايو



اللجنة العلمية ط ٣٦ ب بشري

The Scientific Committee Of The Batch 36 Human Medicine

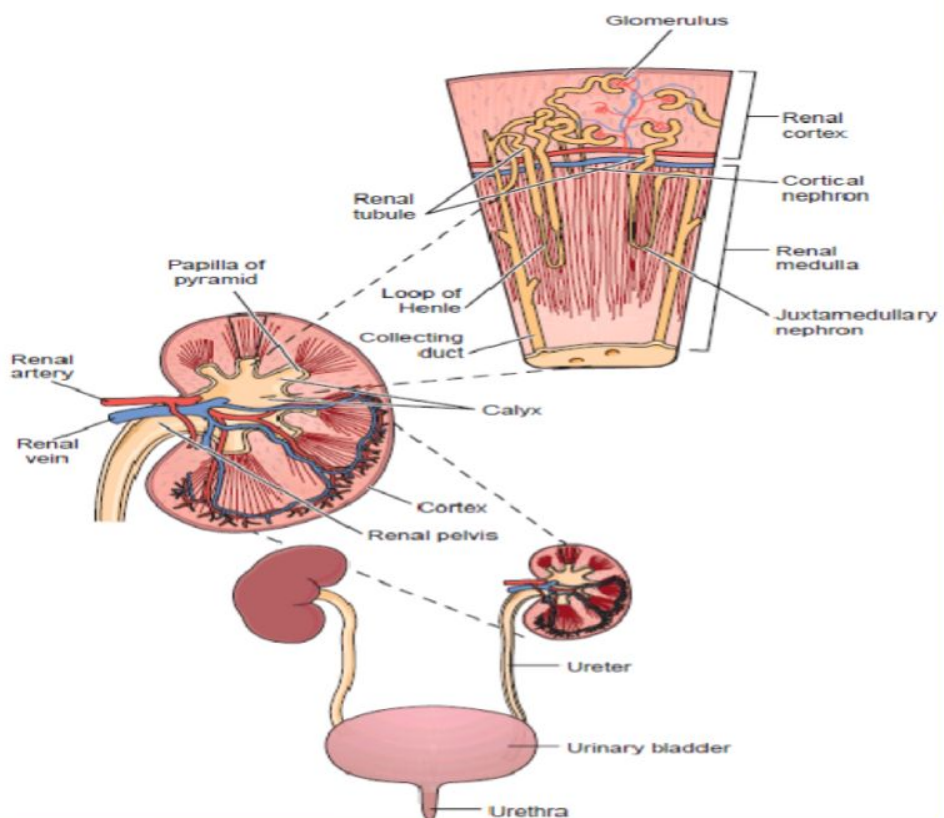
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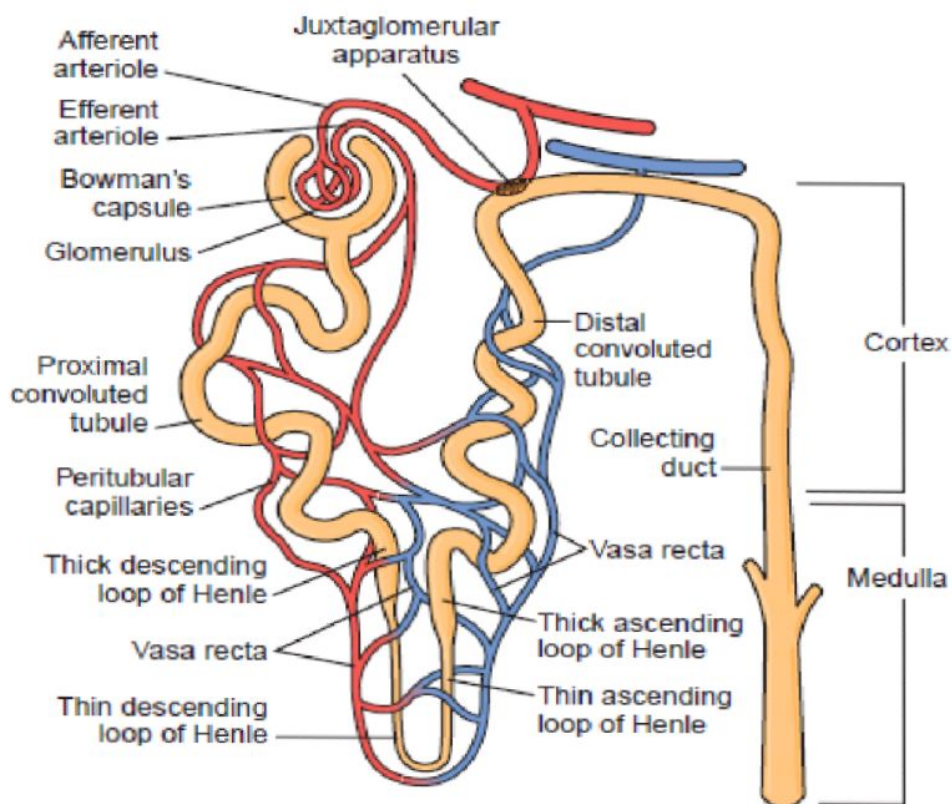
رؤوف الجبر & أفنان العداوي



Urinalysis

- Urine is formed in the kidneys, is a product of ultrafiltration of plasma by the renal glomeruli.





Importance of urine analysis

- It can detect diseases which pass unnoticed.

For example, D.M, chronic UTI.

- Diagnosis of many renal diseases.

As nephrotic, nephritic syndrome, acute renal failure,
multiple myeloma

Table 3–4**Types of Urine Specimens**

Type of Specimen	Purpose
Random	Routine screening
First morning	Routine screening Pregnancy tests Orthostatic protein
Fasting (second morning)	Diabetic screening/monitoring
2-hour postprandial	Diabetic monitoring
Glucose tolerance test	Optional with blood samples in glucose tolerance test
24-h (or timed)	Quantitative chemical tests
Catheterized	Bacterial culture
Midstream clean-catch	Routine screening Bacterial culture
Suprapubic aspiration	Bladder urine for bacterial culture Cytology
Three-glass collection	Prostatic infection

Specimen Collection

- First morning voiding (most concentrated)
- Record collection time
- Type of specimen (e.g. “clean catch”)
- Analyzed within 2 hours of collection
- Free of debris or vaginal secretions

Urine composition

- Urine, a very complex fluid, is composed of **95% water** and **5% solids**. It is the end product of the metabolism carried out by billions of cells and results in an average urinary output of **1-1.5 L per day**.
- Almost all substances found in urine are also found in the blood although in **different concentration**.
- Urine may also contain formed elements such as cells, casts, crystals, mucus and bacteria.

Table 3-1 Composition of Urine Collected for 24 Hours

Component	Amount	Remark
Organic		
Urea	25.0–35.0 g	60%–90% of nitrogenous material; derived from the metabolism of amino acids into ammonia
Creatinine	1.5 g	Derived from creatine, nitrogenous substance in muscle tissue
Uric acid	0.4–1.0 g	Common component of kidney stones; derived from catabolism of nucleic acid in food and cell destruction
Hippuric acid	0.7 g	Benzoic acid is eliminated from the body in this form; increases with high-vegetable diets
Other substances	2.9 g	Carbohydrates, pigments, fatty acids, mucin, enzymes, hormones; may be present in small amounts depending on diet and health
Inorganic		
Sodium chloride (NaCl)	15.0 g	Principal salt; varies with intake
Potassium (K ⁺)	3.3 g	Occurs as chloride, sulfate, and phosphate salts
Sulfate (SO ₄ ²⁻)	2.5 g	Derived from amino acids
Phosphate (PO ₄ ³⁻)	2.5 g	Occurs primarily as sodium compounds that serve as buffers in the blood
Ammonium (NH ₄ ⁺)	0.7 g	Derived from protein metabolism and glutamine in kidneys; amount varies depending on blood and tissue fluid acidity
Magnesium (Mg ²⁺)	0.1 g	Occurs as chloride, sulfate, phosphate salts
Calcium (Ca ²⁺)	0.3 g	Occurs as chloride, sulfate, phosphate salts

Types of Analysis

- Macroscopic Examination
- Chemical Analysis (Urine Dipstick)
- Microscopic Examination
- Culture (not covered in this lecture)
- Cytological Examination

Macroscopic Examination

Volume
Color
Odour
Appearance

Urinary volume

1-volume:

Normal = 600-1550ml

Polyuria - >2000ml

Oliguria <400ml

Anuria - complete cessation of urine (<200ml)

Nocturia - excretion of urine by an adult of >500ml with a specific gravity of <1.018 at night (characteristic of chronic glomerulonephritis)

Causes of polyuria

Diabetes mellitus

Diabetes insipidus

Polycystic kidney

Chronic renal failure

Diuretics

Intravenous saline/glucose

oliguria

Dehydration-vomiting, diarrhoea, excessive sweating

Renal ischemia

Acute tubular necrosis

Obstruction to the urinary tract

Acute renal failure

2-Odor:

- Ammonia-like: (Urea-splitting bacteria)
- Foul, offensive: Old specimen, pus or inflammation
- Sweet: Glucose
- Fruity: Ketones
- Maple syrup-like: Maple Syrup Urine Disease¹-

3-Color:

- Colorless Diluted urine
- Deep Yellow Concentrated Urine, Riboflavin
- Yellow-Green Bilirubin / Biliverdin
- Red Blood / Hemoglobin
- Brownish-red Acidified Blood (Acute GN)
- Brownish-black Homogentisic acid (Melanin)

Table 4-1

Laboratory Correlation of Urine Color¹

Color	Cause	Clinical/Laboratory Correlations
Colorless	Recent fluid consumption	Commonly observed with random specimens
Pale yellow	Polyuria or diabetes insipidus	Increased 24-hour volume
	Diabetes mellitus	Elevated specific gravity and positive glucose test result
	Dilute random specimen	Recent fluid consumption
Dark yellow	Concentrated specimen	May be normal after strenuous exercise or in first morning specimen
Amber		Dehydration from fever or burns
Orange	Bilirubin	Yellow foam when shaken and positive chemical test results for bilirubin
	Acriflavine	Negative bile test results and possible green fluorescence
	Phenazopyridine (Pyridium)	Drug commonly administered for urinary tract infections May have orange foam and thick orange pigment that can obscure or interfere with reagent strip readings
	Nitrofurantoin	Antibiotic administered for urinary tract infections
	Phenindione	Anticoagulant, orange in alkaline urine, colorless in acid urine
Yellow-green	Bilirubin oxidized to biliverdin	Colored foam in acidic urine and false negative chemical test results for bilirubin
Yellow-brown		
Green	<i>Pseudomonas</i> infection	Positive urine culture
Blue-green	Amitriptyline	Antidepressant
	Methocarbamol (Robaxin)	Muscle relaxant, may be green-brown
	Clorets	None
	Indican	Bacterial infections
	Methylene blue	Fistulas
	Phenol	When oxidized

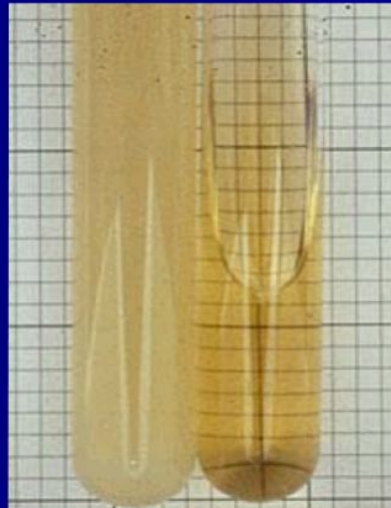
Color	Cause	Clinical/Laboratory Correlations
Pink	RBCs	Cloudy urine with positive chemical test results for blood and RBCs visible microscopically
Red	Hemoglobin	Clear urine with positive chemical test results for blood; intravascular hemolysis
	Myoglobin	Clear urine with positive chemical test results for blood; muscle damage
	Porphyrins	Negative chemical test results for blood Detect with Watson-Schwartz screening test or fluorescence under ultra-violet light
	Beets	Alkaline urine of genetically susceptible persons
	Rifampin	Tuberculosis medication
	Menstrual contamination	Cloudy specimen with RBCs, mucus, and clots
Brown	RBCs oxidized to methemoglobin	Seen in acidic urine after standing; positive chemical test result for blood
Black	Methemoglobin	Denatured hemoglobin
	Homogentisic acid (alcaptonuria)	Seen in alkaline urine after standing; specific tests are available
	Melanin or melanogen	Urine darkens on standing and reacts with nitroprusside and ferric chloride
	Phenol derivatives	Interfere with copper reduction tests
	Argyrol (antiseptic)	Color disappears with ferric chloride
	Methyldopa or levodopa	Antihypertensive
	Metronidazole (Flagyl)	Darkens on standing



Clarity (Transparency).

Normal urine clear or transparent, any turbidity will indicate.

- WBCs (pus).
- RBCs
- Epithelial cells
- Bacteria
- Casts
- Crystals
- Lymph
- Semen.



Appearance

Table 4-2

Urine Clarity

Clarity	Term
Clear	No visible particulates, transparent.
Hazy	Few particulates, print easily seen through urine.
Cloudy	Many particulates, print blurred through urine.
Turbid	Print cannot be seen through urine.
Milky	May precipitate or be clotted.

Chemical Analysis



Chemical Analysis

Dipstick reagent strip method



A color-producing chemical reaction takes place when the absorbent pad comes in contact with urine.

chemical-impregnated absorbent pads attached to a plastic strip.

	Glucose
	Bilirubin
	Ketones
	Specific Gravity
	Blood
	pH
	Protein
	Urobilinogen
	Nitrite
	Leukocyte Esterase

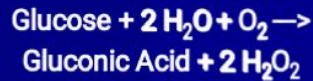
The Urine Dipstick:

Glucose

	Negative
	Trace (100 mg/dL)
	+(250 mg/dL)
	++ (500 mg/dL)
	+++ (1000 mg/dL)
	++++ (2000+ mg/dL)

Chemical Principle

Glucose Oxidase



Horseradish Peroxidase



Read at 30 seconds

RR: Negative

Uses of Urine Glucose Detection

Significance

- Diabetes mellitus.
- Renal glycosuria.
- Pancreatic cancer.
- Acromegaly.
- Cushing syndrome.
- Hyperthyroidism.
- Stress.
- Gestational diabetes

The Urine Dipstick:

Ketones

	Negative
	Trace (5 mg/dL)
	+(15 mg/dL)
	++ (40 mg/dL)
	+++ (80 mg/dL)
	++++ (160+ mg/dL)

Chemical Principle

Acetoacetic Acid + Nitroprusside
→ Colored Complex

Read at 40 seconds
RR: Negative

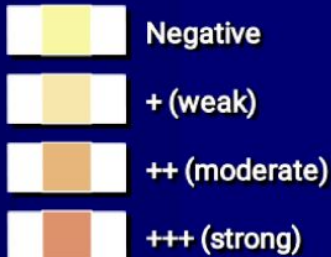
Uses and Limitations of Urine Ketone Detection

Significance

- Diabetic ketoacidosis
- Prolonged fasting
- Starvation
- Vomiting
- Malabsorption

The Urine Dipstick:

Bilirubin



Chemical Principle

Bilirubin + Diazo salt $\xrightarrow{\text{Acidic}}$ Azobillirubin

Read at 30 seconds
RR: Negative

Uses of Urine Bilirubin Detection

Hydrophobic substance difficult to excretion and easy reabsorption.

Its appearance in urine abnormal.

Significance

Hepatitis.
Cirrhosis
Liver disorder.
Biliary obstruction.

The Urine Dipstick:

Urobilinogen

	0.1 mg/dL
	1 mg/dL
	2 mg/dL
	4 mg/dL
	8 mg/dL

Chemical Principle

Urobilinogen + Diethylaminobenzaldehyde
(Ehrlich's Reagent)

————> Colored Complex

Read at 60 seconds

RR: 0.02-1.0 mg/dL

Uses of Urobilinogen Detection

Significance

- High: increased hepatic processing of bilirubin
- Low: bile obstruction

The Urine Dipstick:

Specific Gravity

-Specific gravity is defined as the *density* of a solution compared with the density of a similar volume of distilled water at a similar temperature.

-ability of the kidneys to selectively reabsorb essential chemicals and water from the glomerular filtrate



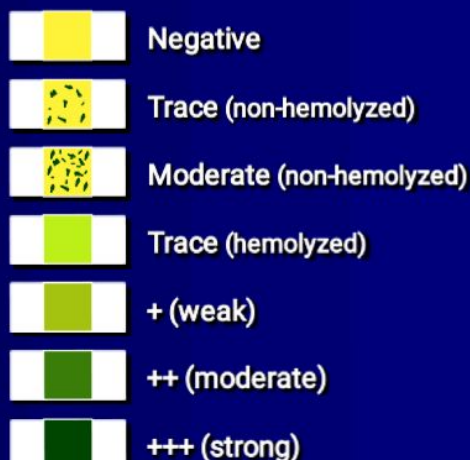
Chemical Principle

$X^+ + \text{Polymethyl vinyl ether} / \text{maleic anhydride} \longrightarrow X^+ - \text{Polymethyl vinyl ether} / \text{maleic anhydride} + H^+$
 H^+ interacts with a Bromthymol Blue indicator to form a colored complex.

Read up to 2 minutes
RR: 1.003-1.035

The Urine Dipstick:

Blood



Chemical Principle

Lysing agent to lyse red blood cells

Diisopropylbenzene dihydroperoxide + Tetramethylbenzidine

Heme $\longrightarrow$ Colored Complex

Read at 60 seconds
RR: Negative
Analytic Sensitivity: 10 RBCs

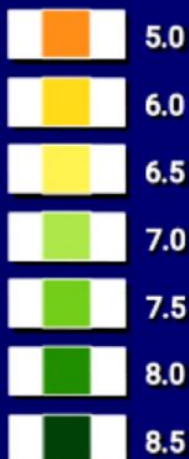
Uses of Urine Blood Detection

Significance

- Hematuria (nephritis, trauma, etc)
- Hemoglobinuria (hemolysis, etc)
- Myoglobinuria (rhabdomyolysis, etc)

The Urine Dipstick:

pH



Chemical Principle

H⁺ interacts with:
Methyl Red (at high concentration; low pH) and
Bromthymol Blue (at low concentration; high pH),
to form a colored complexes
(dual indicator system)

Read up to 2 minutes
R.R.: 4.5-8.0

Uses and Limitations of Urine pH Detection

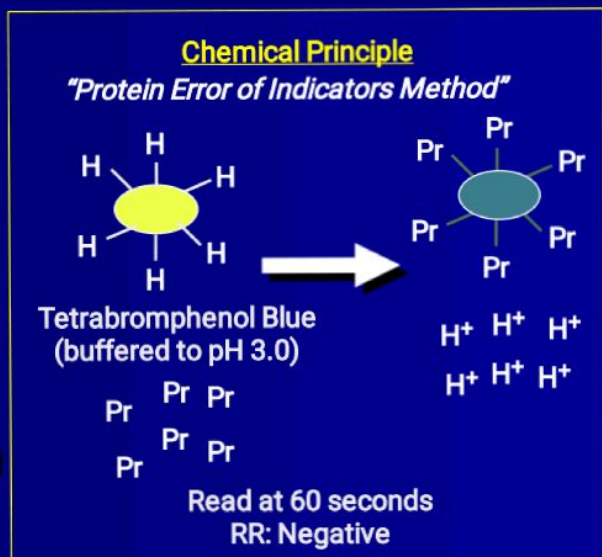
Significance

- Acidic (less than 6.7): metabolic acidosis, high-protein diet, Diabetes mellitus, Dehydration, Medication.
- Alkaline (greater than 8.0): renal tubular acidosis, Hyperventilation, Vomiting, presence of urease producing bacteria.

The Urine Dipstick:

Protein

	Negative
	Trace
	+(30 mg/dL)
	++(100 mg/dL)
	+++ (300 mg/dL)
	++++ (2000 mg/dL)



Proteins in "Normal" Urine

Protein % of Total Daily Maximum

Albumin 40% 60 mg

Tamm-Horsfall 40% 60 mg

Immunoglobulins 12% 24 mg

Secretory IgA 3% 6 mg

Other 5% 10 mg

TOTAL 100% 150 mg

Causes of Proteinuria

Renal

- Glomerulonephritis
- Nephrotic syndrome
- Renal tumor or infection

Pre-Renal Post-Renal

- | | |
|-----------------|---|
| - Fever | - Cystitis |
| - Renal hypoxia | - Urethritis or prostatitis |
| - Hypertension | - Contamination with vaginal secretions |

Uses of Urine Protein Detection

Significance

nephrotic syndrome.

The Urine Dipstick:

Nitrite



Negative



Positive

Chemical Principle

Nitrite + p-arsenilic acid $\xrightarrow{\text{Acidic}}$ Diazo compound

Diazo compound + Tetrahydrobenzoquinolinol
 $\longrightarrow$ Colored Complex

Read at 60 seconds
RR: Negative

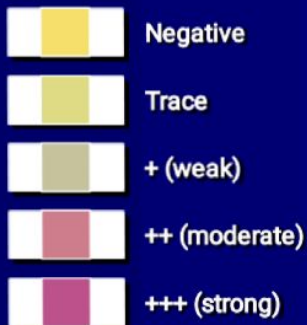
Uses of Nitrite Detection

Significance

- Gram negative bacteriuria

The Urine Dipstick:

Leukocyte Esterase



Chemical Principle

Derivatized pyrrole amino acid ester

Esterases → 3-hydroxy-5-phenyl pyrrole

3-hydroxy-5-phenyl pyrrole + diazo salt
→ Colored Complex

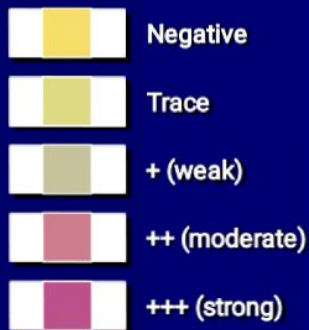
Read at 2 minutes

RR: Negative

Analytic Sensitivity: 3-5 WBCs

The Urine Dipstick:

Leukocyte Esterase



Chemical Principle

Derivatized pyrrole amino acid ester

Esterases → 3-hydroxy-5-phenyl pyrrole

3-hydroxy-5-phenyl pyrrole + diazo salt
→ Colored Complex

Read at 2 minutes

RR: Negative

Analytic Sensitivity: 3-5 WBCs

Uses Leukocyte Esterase Detection

Significance

- Pyuria
- Acute inflammation
- Renal calculus

Microscopic Examination procedure

■ Centrifugation:

- 1- put 9-11 ml of urine sample in to test tube.
- 2-The urine centrifugation is 5 minute at 1200 rpm
- 3- Discard supernatant and place one drop of sediment in glass slide.
- 4-place the glass slide on the microscope.

Classification of urine sediment

Organized elements:

- 1-Epithelial cells
- 2-Leukocytes.
- 3-Erythrocytes.
- 4-casts.
- 5-Bacteria,Yeast,Parasite ,sperm

■ **Unorganized elements:**

1-Crystals.

2-Mucus threads.

Microscopic Examination

Abnormal Findings

Per High Power Field (HPF) (40 x)

- > 3 erythrocytes
- > 5 leukocytes
- > 2 renal tubular cells
- > 10 bacteria

Per Low Power Field (LPF) (10x)

- > 3 hyaline casts or > 1 granular cast
- > 10 squamous cells (indicative of contaminated specimen)
- Any other cast (RBCs, WBCs)

Presence of:

- Fungal hyphae or yeast, parasite, viral inclusions
- Pathological crystals (cystine, leucine, tyrosine)
- Large number of uric acid or calcium oxalate crystals

Microscopic Examination

Organized elements:

1-Erythrocytes > 3 erythrocytes

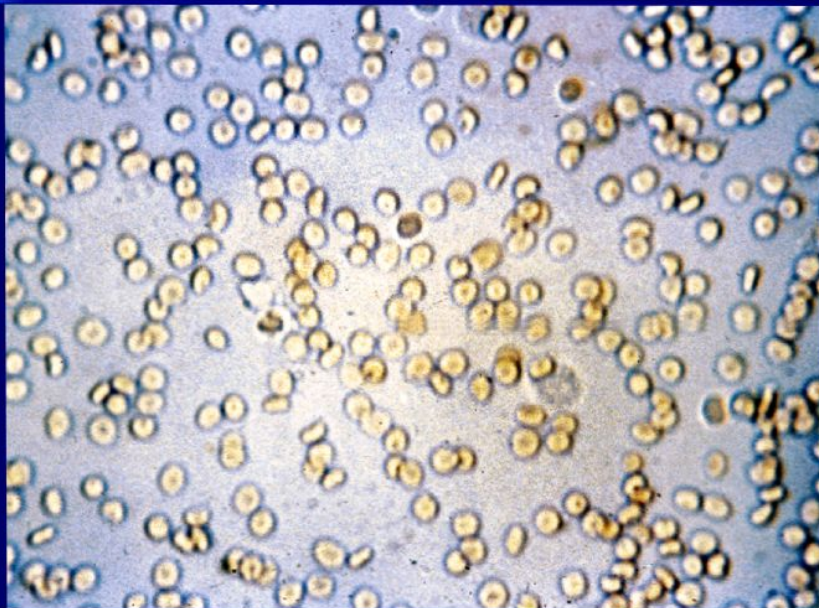
2-Leukocytes > 5 leukocytes

3-Epithelial Cells

- Squamous cells > 10 Indicate level of contamination
- Renal tubular epithelial cells > 2 Few are normal
- Transitional epithelial cells > 2 Few are normal
- Oval fat bodies Abnormal, indicate Nephrosis

Microscopic Examination

RBCs



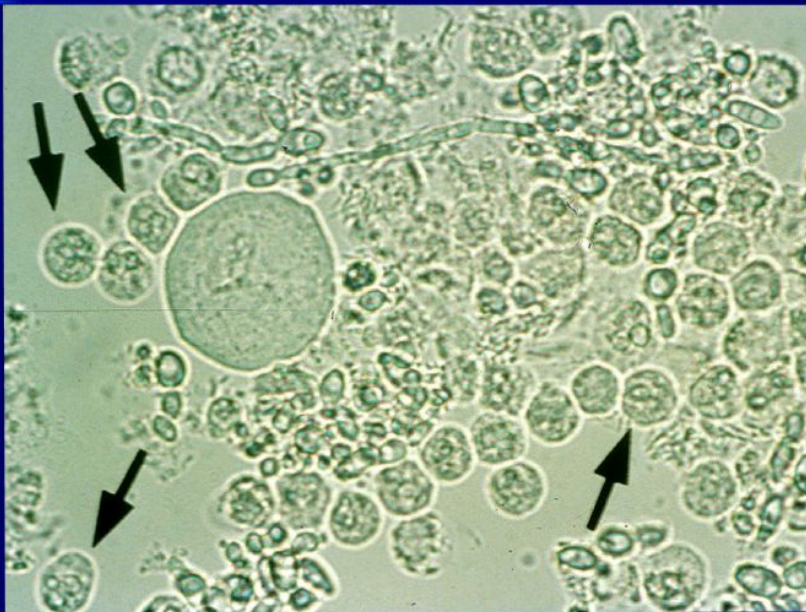
Microscopic Examination

RBCs



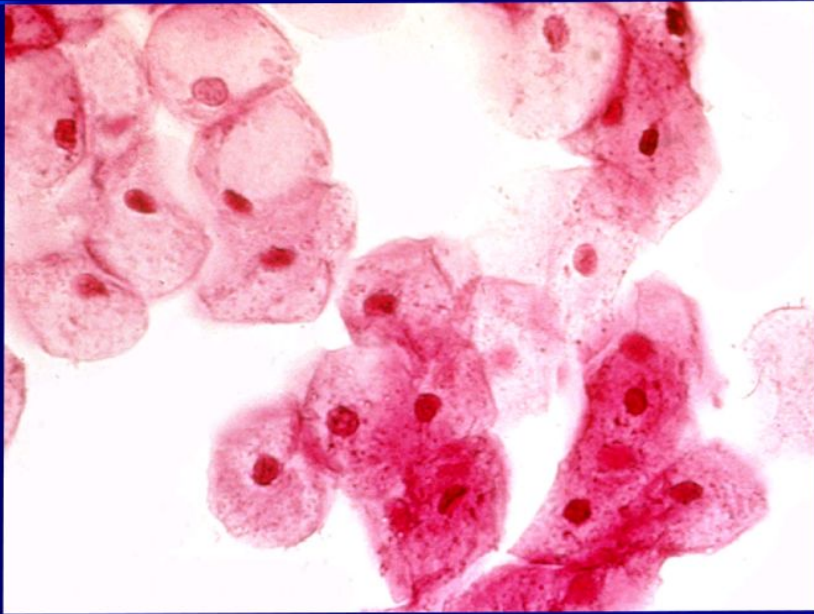
Microscopic Examination

WBCs

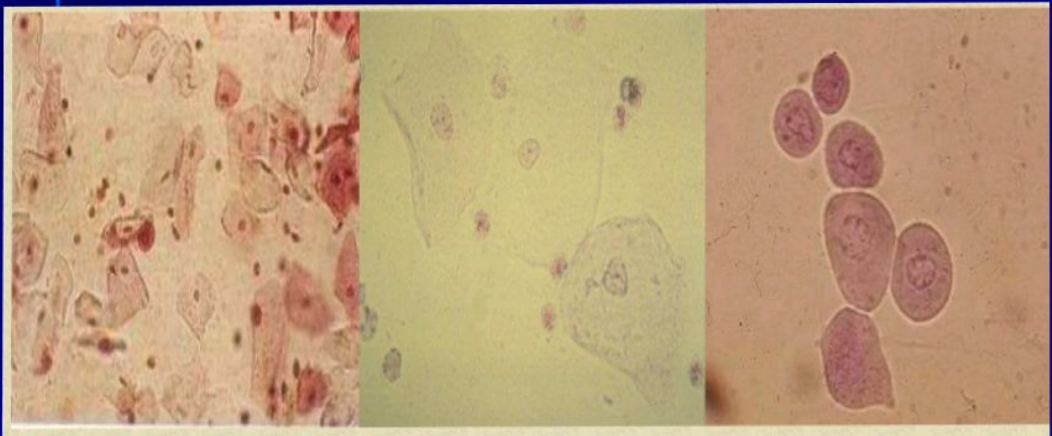


Microscopic Examination

Squamous Cells

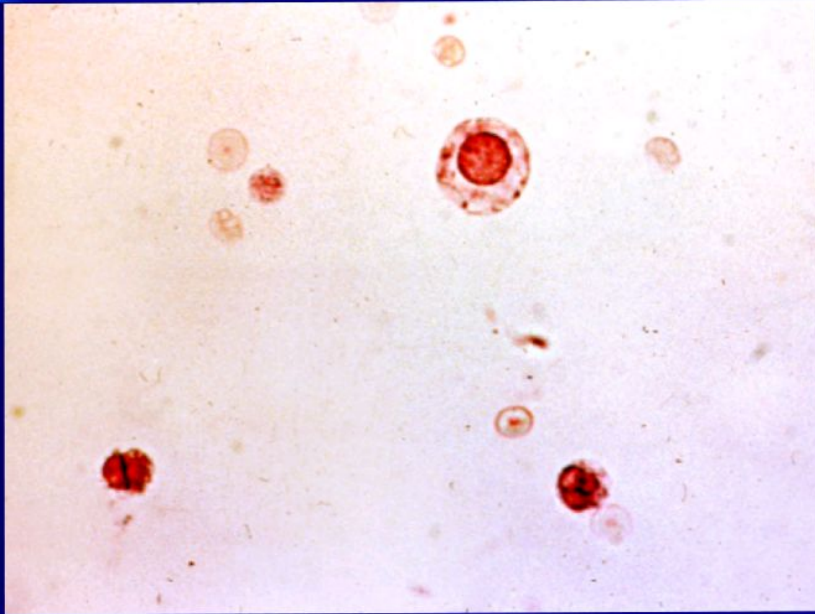


Squamous Cells



Microscopic Examination

Tubular Epithelial Cells

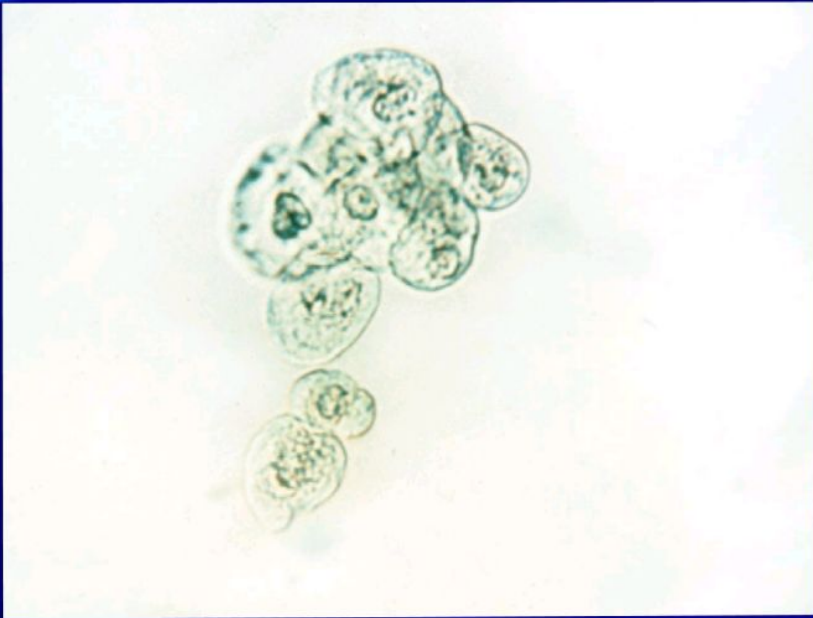


Tubular Epithelial Cells



Microscopic Examination

Transitional Cells



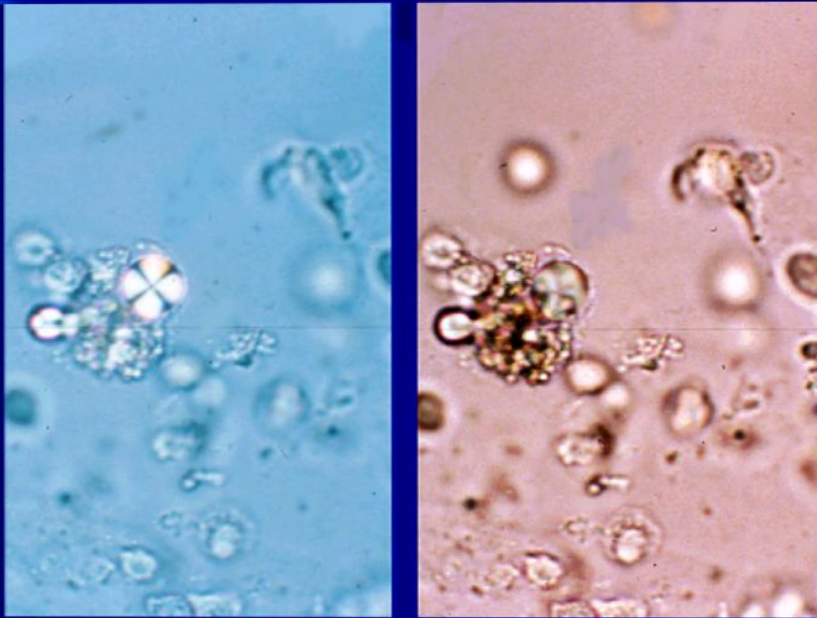
Microscopic Examination

Transitional Cells



Microscopic Examination

Oval Fat Body



Microscopic Examination

LE Cell



Microscopic Examination

Bacteria & Yeasts

Bacteria

- Bacteriuria More than 10 per HPF

Yeasts

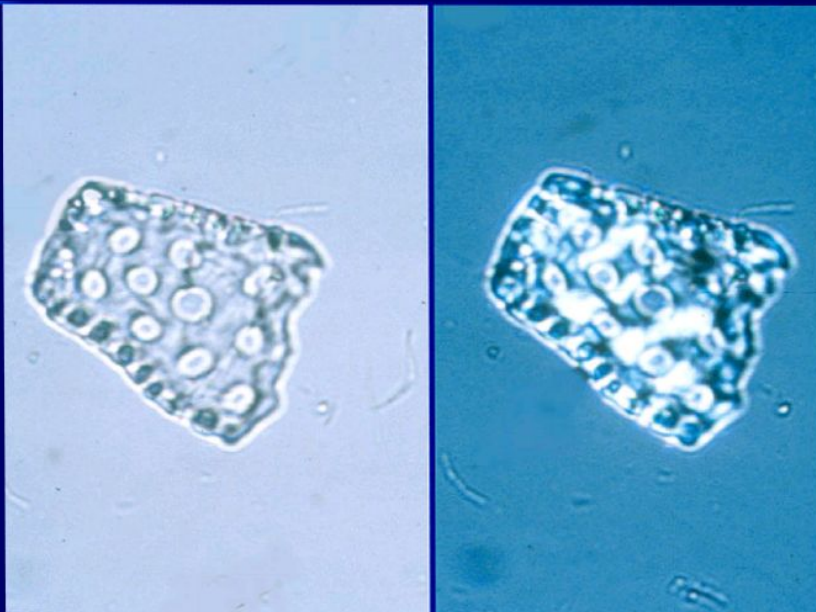
- Candidiasis Most likely a contaminant but should correlate with clinical picture.

Viruses

- CMV inclusions Probable viral cystitis.

Microscopic Examination

Bacteria



Microscopic Examination

Yeasts



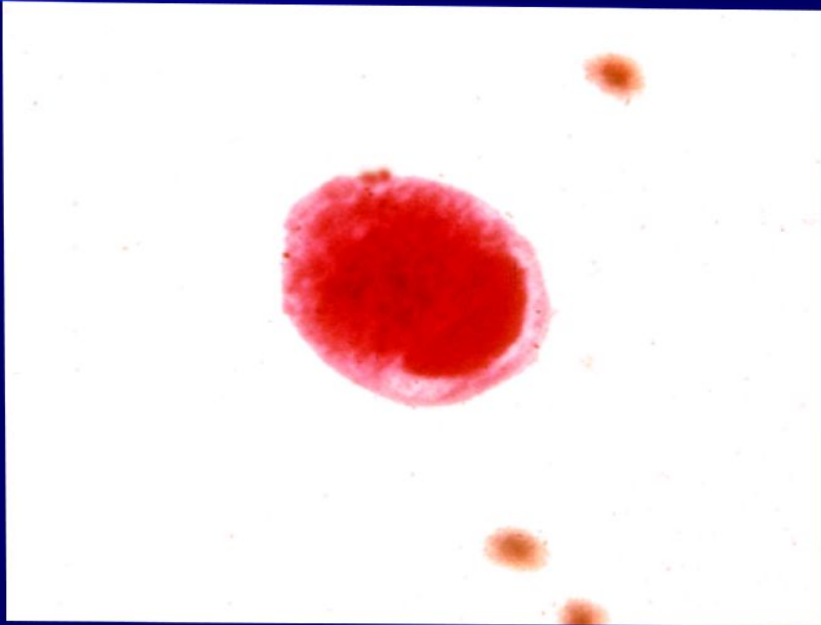
Microscopic Examination

Yeasts



Microscopic Examination

Cytomegalovirus



Microscopic Examination

Casts

Erythrocyte Casts: Glomerular diseases

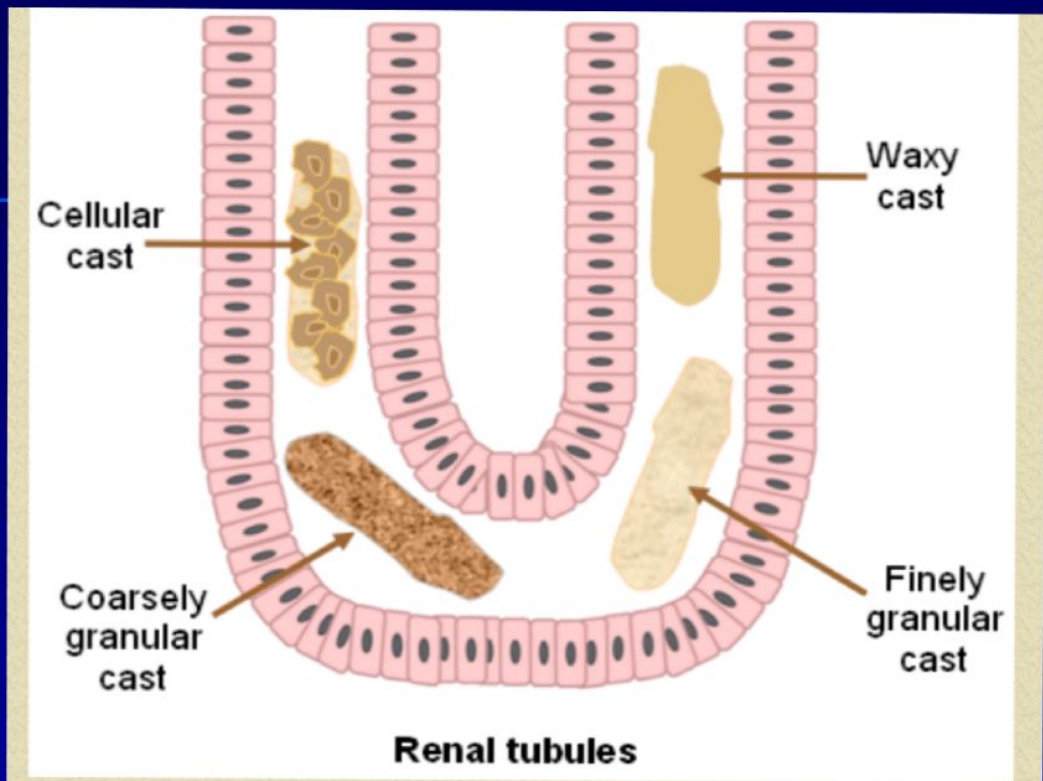
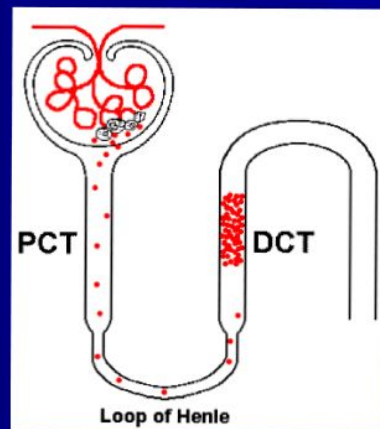
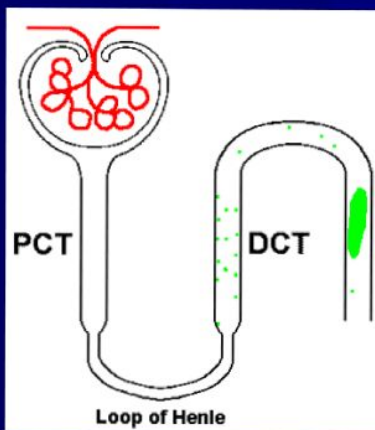
Leukocyte Casts: Pyuria, glomerular disease

Degenerating Casts:

- Granular casts Nonspecific (Tamm-Horsfall protein)
- Hyaline casts Nonspecific (Tamm-Horsfall protein)
- Waxy casts Nonspecific
- Fatty casts Nephrotic syndrome
(oval fat body casts)

Microscopic Examination

Casts



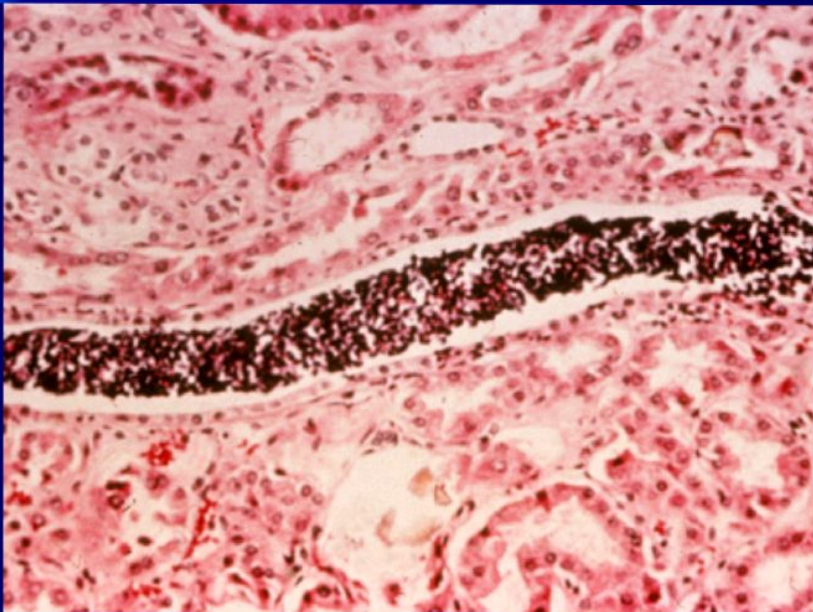
Microscopic Examination

RBCs Cast



Microscopic Examination

RBCs Cast - Histology



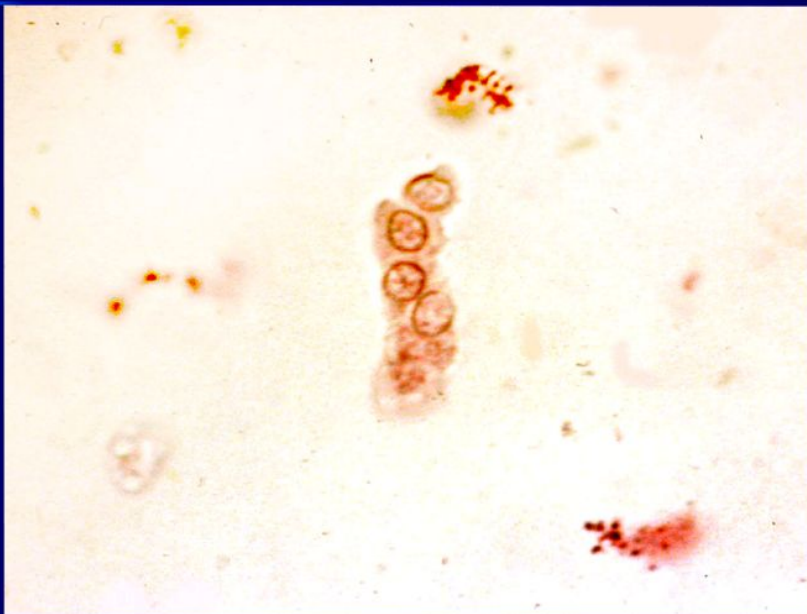
Microscopic Examination

WBCs Cast



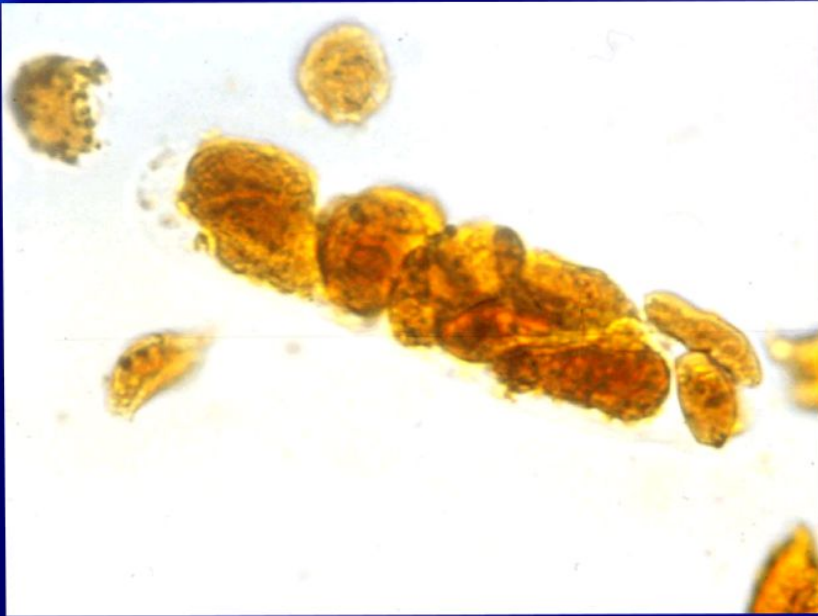
Microscopic Examination

Tubular Epith. Cast



Microscopic Examination

Tubular Epith. Cast



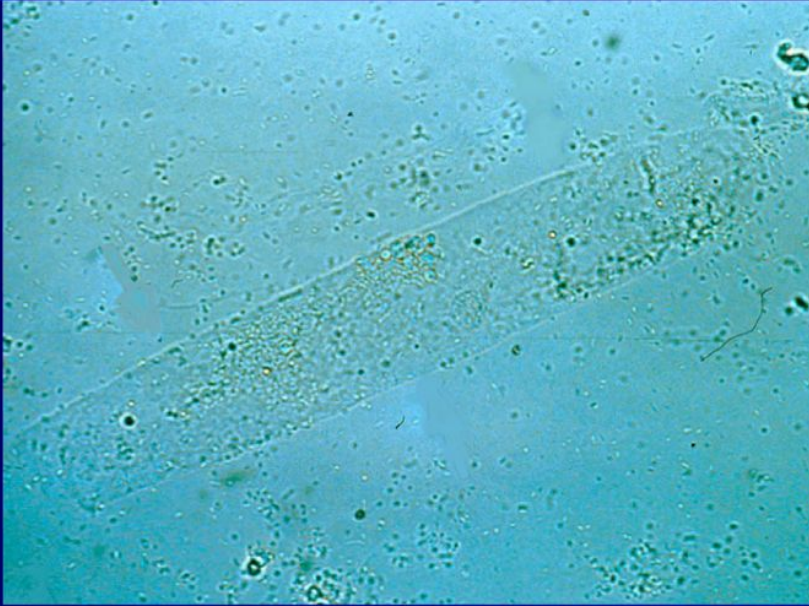
Microscopic Examination

Granular Cast



Microscopic Examination

Hyaline Cast



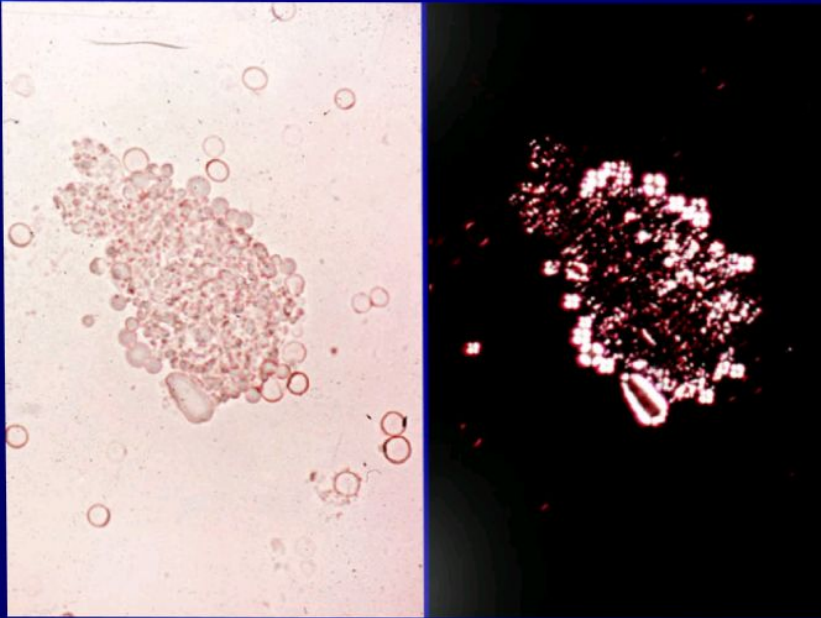
Microscopic Examination

Waxy Cast



Microscopic Examination

Fatty Cast



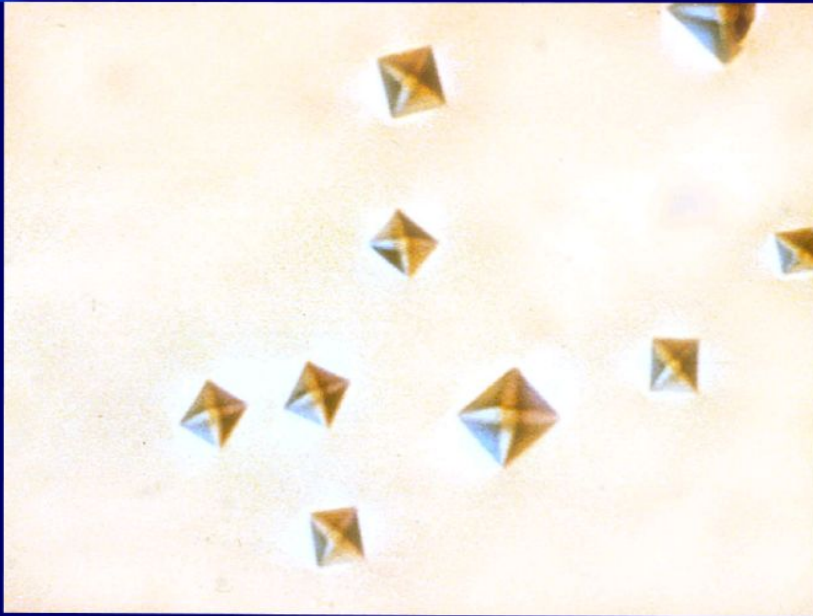
Microscopic Examination

Crystals

- **Urate**
 - Ammonium biurate
 - Uric acid
- **Triple Phosphate**
- **Calcium Oxalate**
- **Amino Acids**
 - Cystine
 - Leucine
 - Tyrosine
- **Sulfonamide**
- **Amorphous .**

Microscopic Examination

Calcium Oxalate Crystals



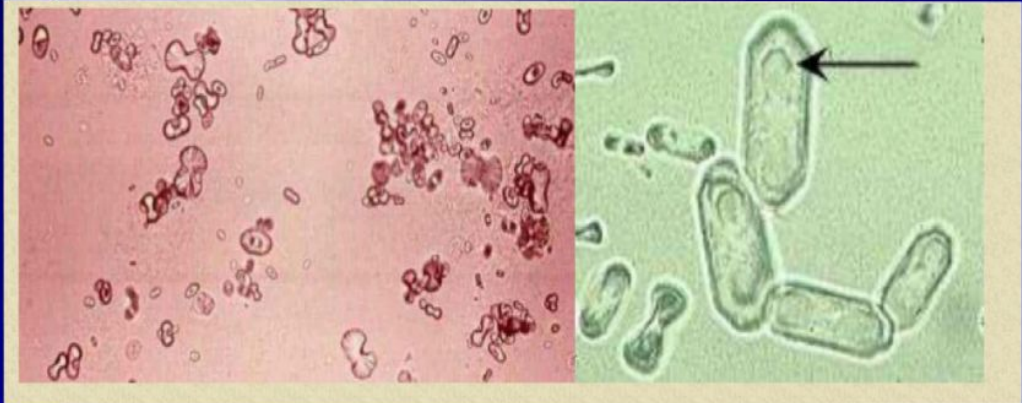
Microscopic Examination

Calcium Oxalate Crystals



Dumbbell Shape

Calcium Oxalate Crystals

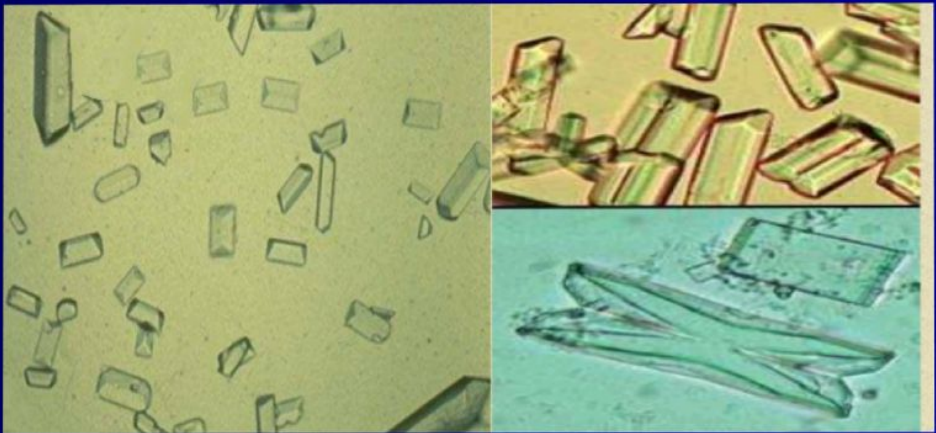


Microscopic Examination

Triple Phosphate Crystals

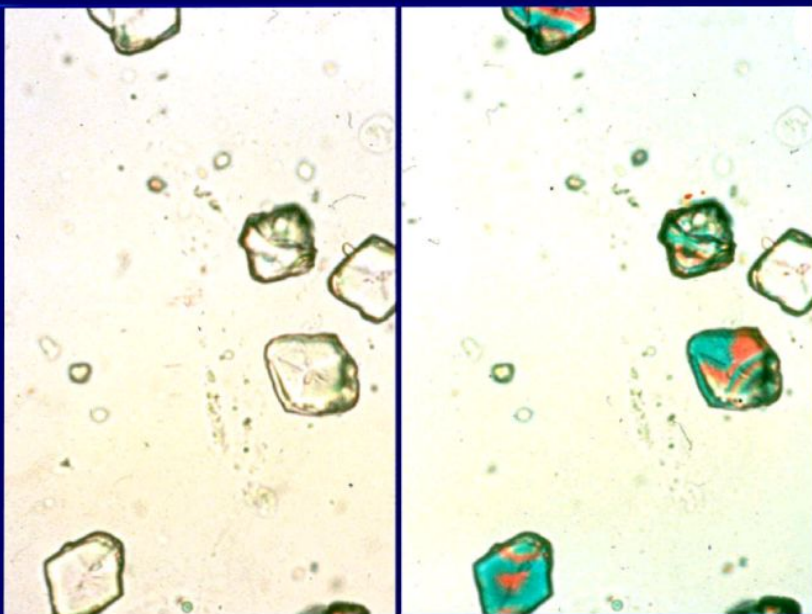


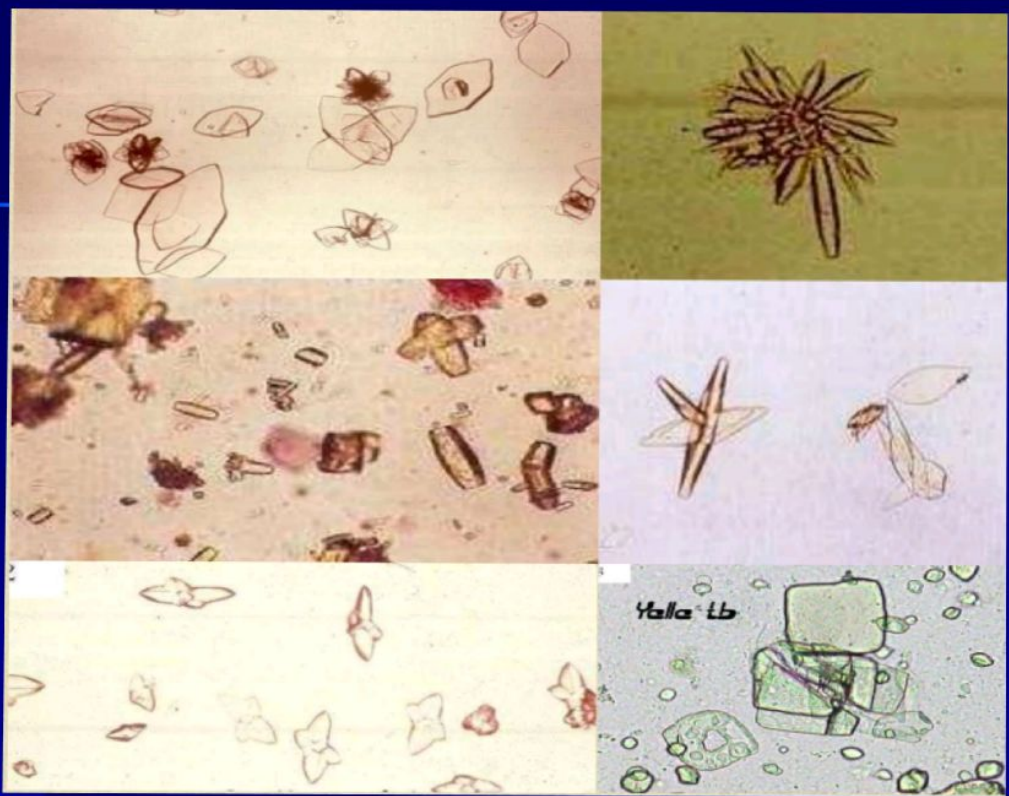
Triple Phosphate Crystals



Microscopic Examination

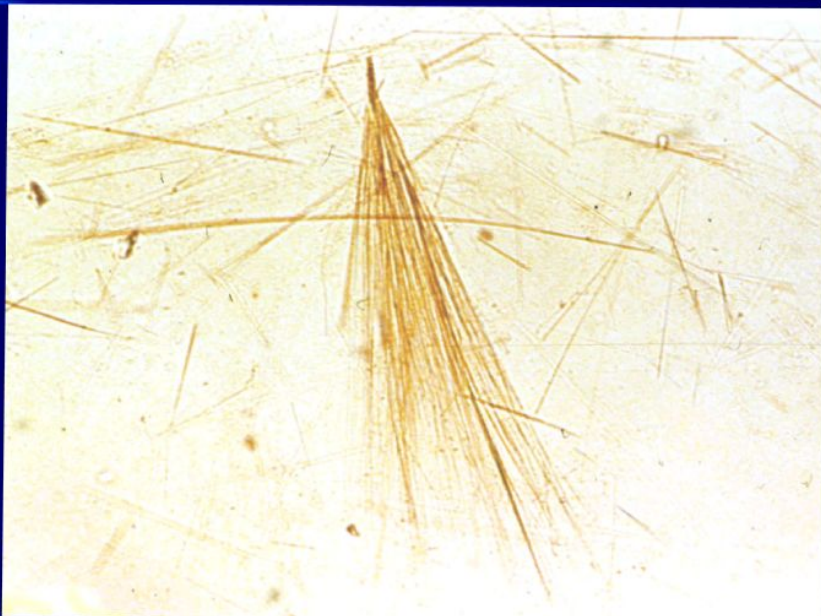
Urate Crystals





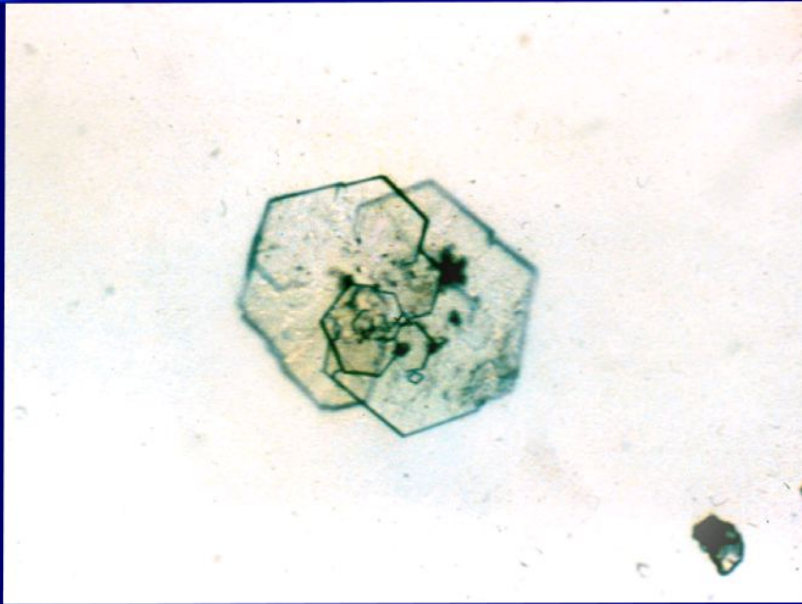
Microscopic Examination

Leucine Crystals



Microscopic Examination

Cystine Crystals



Microscopic Examination

Ammonium Biurate Crystals



Microscopic Examination

Cholesterol Crystals

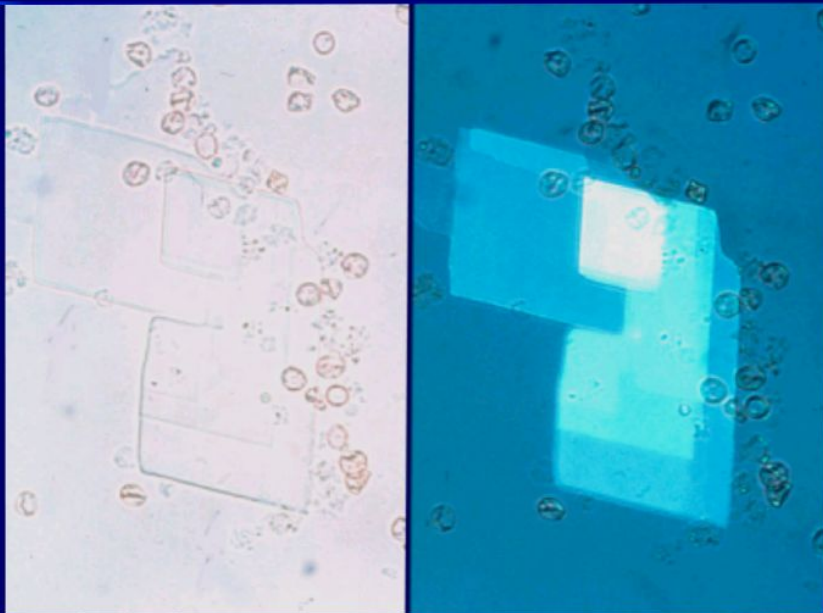
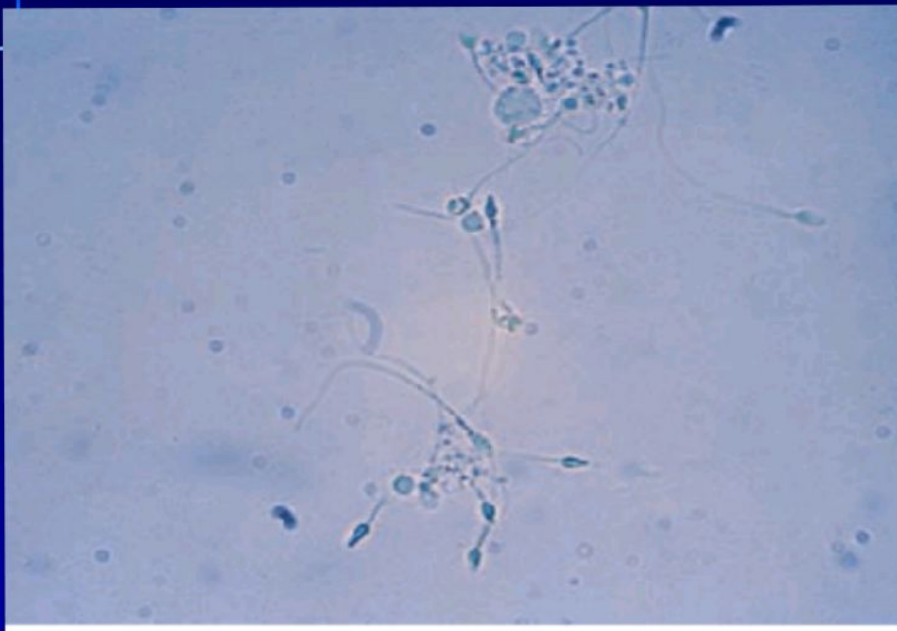


Table 6-2

Routine Urinalysis Correlations

Microscopic Elements	Physical	Chemical	Exceptions
RBCs	Turbidity Red color	+ Blood	Number Hemolysis
WBCs	Turbidity	+ Protein + Nitrite + Leukocytes	Number Lysis
Epithelial cells	Turbidity		Number
Casts		+ Protein	Number
Bacteria	Turbidity	pH + Nitrite + Leukocytes	Number and type
Crystals	Turbidity Color	pH	Number and type

sperm



Mucus



Kidney function tests

- 1- Urea
- 2 - Creatinine
- 3 - Uric acid
4. Creatinine Clearance.

II. Estimation of Blood urea.

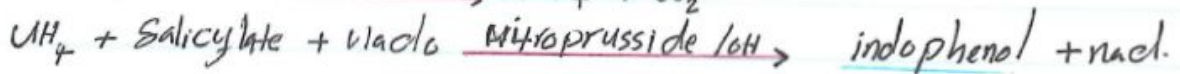
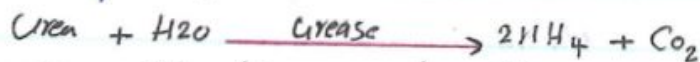
* Urea: is the end product of protein Metabolism.

* Factors that effect level of urea.

- 1- Diet
- 2- Age
- 3- hydration
- 4- dehydration.
- 5- protein Metabolism.

Urea test

II. principles



the intensity of colour directly proportional to concentration of Urea.

2- Method.

	Blank	STD	Sample
Reagent A	1 ml	1 ml	1 ml.
STD.	—	10 μm	—
Sample.	—	—	10 m.
	wait for 5 minute.		
Reagent B	1 ml	1 ml	1 ml.
	wait for 10 minute. at "RT"		

31. Calculation:

$$\text{Concentration of urea (mg/dl)} = \frac{\text{Abs. of Sample} \times \text{Conc. of STD}}{\text{Abs. of STD}}$$

* BUN: Blood urea nitrogen.

$$\text{BUN} = \frac{\text{result of urea}}{2.14}$$

- Measurement of concentration of 'N' in urea in the blood without concentration of (H, O, C...).

$$= \frac{\text{Molecular weight of urea}}{\text{molecular weight of N}} = \frac{60}{28} = 2.14.$$

range	Comment	interpretation.
15-40 mg/dl	Normal	—
< 15 mg/dl.	hypouremia.	1. severe hepatic damage. 2. Malnutrition 3. over hydration 4. some drugs, " chloramphenicol 5. late pregnancy.
> 40 mg/dl	hyperuremia	pre renal = 1. decrease renal BF. 2. Dehydration 3. Burns 4. Gastro intestinal Bleeding. 5. condition associated with renal protein break down. renal: damage of glomeruli or tubular. post renal: 1. urinary tract obstruction 2. prostatic hypertrophy.

Creatinine Test.

1. Creatine made in liver and kidney.
2. It's stored in skeletal muscle as creatine phosphate.
3. In contraction of muscle it break down to phosphate and creatinine.
4. So creatinine is a waste product go to the kidney then excreted in urine.
5. Creatinine affected by muscle mass, so it's higher in male than female.
6. No absorption for creatinine.

the test

1. principle -

creatinine + picric acid. Alkaline medium. creatinin picric complex

the intensity of colour directly proportional to the concentration of creatinine sample.

2. Method.

W.R 1 ml

sample 100 ml.

Read A_1 after 30 second then A_2 after 90 second.
"1:30"

3. Calculation - "Blood"

$$\text{Concentration of creatinine (mg/dl)} = \frac{\Delta(A_2 - A_1) \text{ of sample}}{\Delta(A_2 - A_1) \text{ of STD}} \times \text{Conc. of STD. (2 mg/dl)}$$

urine creatinine

$$\text{Conc. of creatinine} = \frac{\Delta(A_2 - A_1) \text{ sample}}{\Delta(A_2 - A_1) \text{ STD}} \times \text{Conc. of STD} \times 10 \quad (\text{dilution factor})$$

Normal range for urine sample:

- Male: 21 - 26 mg/dl

- Female: 16 - 22 mg/dl.

range	comment	Interpretation.
male 0.6 - 1.1 mg/dl female 0.5 - 0.9 mg/dl	Normal.	
More than 1.1 or 0.9	High creatinine level.	- pre renal 1. ↓ Blood Flow, Ex: CHF 2. Dehydration, Ex: Burns 3. Muscle injury. "temporary". - renal: acute, chronic renal disease. - post renal. 1. urinary tract obstruction 2. prostatic enlargement.
< 0.6 or < 0.5	low creatinine level.	1. low muscle mass Ex: muscle dystrophy. 2. pregnancy 3. liver problem 4. Diet.
"less serious condition"		

hyper urimia but normal creatinine.

هناك زيادة في اليوريا

هذا لا يعني أن هناك مرض في الكلى

Dehydration - high protein intake. or drugs.

this mean the problem is pre-renal.

creatinine clearance test.

5,

* Urine Volume : "24 - hour"

- measure the amount of urine produces in a day. and this is a part of the creatinine clearance test.
- it's not important to do this at hospital, patient can collect urine at home.
- the test should begin at a specific time and end at the same time on the following day, usually begin in the morning.

* steps:

- 1- give the patient container or more.
- 2- tell him that "First urination" should be out the container because it contain bacteria and this bacteria proliferate itself and it will break the creatinine.
- 3- keep the container in refrigerator ($2-3^{\circ}\text{C}$) or ($4-8^{\circ}\text{C}$) and make sure the cover on the container is tight.

measuring cylinder $\frac{\text{urine}}{\text{volume of urine}}$ $\frac{\text{urine creatinine}}{99 \text{ ml water}}$

clearance:

define as that volume of plasma which the measured substance completely eliminated in the urine per minute of time.

creatinine clearance

the rate of which the kidney clear the creatinine from glomerular filtration.

Calculation crcl.

GFR: Glomerular Filtration rate.

we have two equations:

1. Crcl "urine / plasma"

$$\text{Crcl ml/minute} = \frac{\text{urine creatinine} \times \text{volume of 24 hr. urine}}{\text{Plasma creatinine} \times 1440}$$

2. Cockcroft gault formula.

$$\text{GFR} = \frac{(140 - \text{Age}) \times \text{weight (kg)}}{72 \times \text{Serum creatinine}}$$

if female $\times 0.85$

Normal range =

Female = 85 - 125 ml/minute.

Male = 45 - 135 ml/minute.

↓ crcl significant.	↑ crcl. not significant.
1- Glomerulus damage. 2- ↓ RBF "shock - hemorrhage + Dehydration 3- Acute tubular necrosis. 4- T-B 5- tumor 6- error in collection.	1- error in time of clearance. 2- error in specimen collection. 3- both. 4- pregnancy. 5- exercise 6- Burn 7- Posining.

Cystatine C = (protein)

- 1- low MW & molecular weight
- 2- produce by nucleotide cells.
- 3- freely filtered by the glomerulus - reabsorbed and catabolized.
- 4- produce at constant rate remain stable if kidney function is normal

BUN / creatinine ratio

Range	Comment	Cause.
$10 \pm 1 - 20 \pm 1$	normal or Post renal	— prostatic Tumor.
$>20 \pm 1$	pre renal	1- $\downarrow$ renal blood flow 2- GIT bleeding. 3- $\uparrow$ protein.
$<10 \pm 1$	Renal	1- renal damage 2- Obstruction of renal artery.

Uric acid.

Uric acid, it's a purine compound which circulate in the plasma as urate salt derived from breakdown of purine compound.

Source of uric acid

1. Exo:

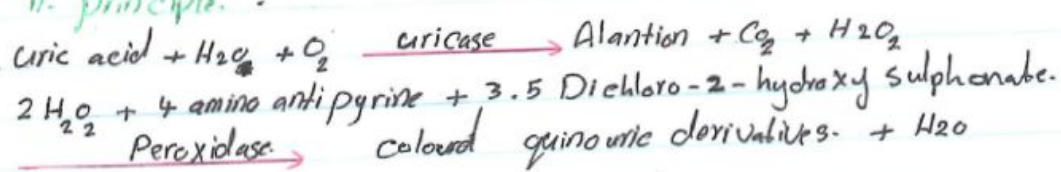
Diet which rich with purine like: meat.

2. Endo:

from the catabolism of purine in cell.

Uric acid test

1. principle.



2. Methods	Blank	STD	Sample.
Reagent	1 ml	1 ml	1 ml
STD	—	20 M.	—
Sample	—	—	20 M

- wait 10 minute. At RT (37°C) -
- wave length : 505 nm

3. Calculation

$$\text{Concentration of uric acid} = \frac{\text{Abs. of sample} \times \text{Conc. of STD}}{\text{Abs. of STD}} \quad \left(\frac{10}{10} \right)$$

"mg/dl"

range.	Comment	interpretation.
2.5 - 7 mg/dl.	Normal	—
> 7 mg/dl	hyperuricemia	1. Gout 2. genetic 3. ↑ break down of body cell in some type of cancer. 4. alcohol 5. obesity 6. ↓ PTH 7. some drugs 8. ↑ purine diet.
< 2.5 mg/dl	hypouricemia	- ↓ purin diet - severe hepatic disease. - Fanconi syndrome - Wilson's disease. - some drugs.

Gastric Juice.

- Normal constituents:

- 1. Mucin = lubrication - protection.
- 2. HCl : pepsin - pH = 1-2
- 3. pepsin proteolysis.
- 4. Rennin clotting ^{milk} (infant)
- 5. Gastrin stimulate secretion of HCl.
- 6. lipase. digestion of Fat.

- Abnormal Constituents:

- 1. lactic acid. : Gastric Carcinoma.
- 2. blood peptic ulcer - Gastric tube.
- 3. hyperacidity. ulcer
- 4. bile regurgitation
- 5. starch. delay in empty of the stomach.

HCl test.

Gastric Juice acid by litmus paper change to red.

test of starch in gastric Juice.

- take 1/2 ml of Gastric Juice with one drop iodine
- observation:
 - if change to blue colour.
- result
 - the starch present in the Gastric Juice.

bile Juice:

to identify presence of bile salts.

20. Hays test

- method

2 ml of bile Juice

Pinch sulphur

- observations

Sulphur sink to the bottom of the tube.

- Result.

bile salt is present.

if the pinch sulphur at the upper of the tube $\rightarrow$ bile salts is absent.

21. Peltenkofer's test

- method.

- 2 ml of bile Juice.

- 2 drop of sucrose.

- 2 ml of H_2SO_4

- observation.



$\rightarrow$ violet ring between two layers.

- Result.

bile salt is present.

31. pH test

- by litmus paper

- the litmus paper change to blue colour.

Urinalysis

Disease Diagnosis

Case 1

Diluted urine, request a voided urine in the morning
If persisting low SG, possible diabetes insipida
A microscopic may give negative results

Glucose	Negative
Bilirubin	Negative
Ketones	Negative
S.G.	1.001
Blood	Negative
pH	5.5
Protein	Negative
Urobilinogen	0.2 mg/dL
Nitrite	Negative
L.E.	Negative

A 35-year old man undergoing routine pre employment drug screening.

Physical characteristics: Clear.
Microscopic: Not performed.
Drugs Identified: None.

Questions:

- What is your differential diagnosis?
- What would you do next to confirm your suspicion?
- Would you order a microscopic analysis on this sample?

Case 2

Possible gallbladder or hepatic disease.
No hemolytic anemia. Perform bilirubins in serum
Microscopic unlikely to provide additional info

Glucose		Negative
Bilirubin		+++
Ketones		Negative
S.G.		1.020
Blood		Negative
pH		5.5
Protein		Negative
Urobilinogen		0.2 mg/dL
Nitrite		Negative
L.E.		Negative

A 42-year old woman presents with "dark urine"

Physical characteristics: Red-brown.
Microscopic: Not performed.

Questions:

- What is your differential diagnosis?
- Could this be a case of hemolytic anemia?
- How would you rule it out?
- What tests would you order next? Why?
- Would you order a microscopic analysis?

Case 3

Possible UTI, request culture and antibiotic sensitivity
Negative Nitrite test: Gram positive bacteria
Lower SG may show less number of cells and bacteria
Un-common diagnosis in this type of patient

Glucose		Negative
Bilirubin		Negative
Ketones		Negative
S.G.		1.030
Blood		+++
pH		6.5
Protein		Trace
Urobilinogen		1.0 mg/dL
Nitrite		Negative
L.E.		+++

A 42-year old man presents painful urination

Physical characteristics: dark red, turbid
Microscopic: leukocytes = 30 per HPF
RBCs = >100 per HPF
Bacteria = >100 per HPF

Questions:

- What is your suspected diagnosis?
- What would you do next?
- What do you make of the nitrite test?
- How would the microscopic exam differ if the S.G. were 1.003?
- Is this a common diagnosis for this type of patient?

Diabetes

Case 4

May be decompensated and with ketoacidosis
Ketones should become negative after treatment

Glucose		++
Bilirubin		Negative
Ketones		Trace
S.G.		1.015
Blood		Negative
pH		6.0
Protein		Negative
Urobilinogen		1.0 mg/dL
Nitrite		Negative
L.E.		Negative

A 27-year old woman presents with severe abdominal pain.

Physical characteristics: turbid
Microscopic: Not performed.

Questions:

- What is the most likely diagnosis?
- What do you make of the ketone result?
- What do you expect to happen to the ketone measurement when treatment begins?

Glomerulonephritis

Case 5

RBC casts reveals renal cortex involvement
RBC cast are not always present in GN

Glucose		Negative
Bilirubin		Negative
Ketones		Negative
S.G.		1.015
Blood		+++
pH		6.5
Protein		+
Urobilinogen		1.0 mg/dL
Nitrite		Negative
L.E.		Negative

8-year old boy presents with red urine

Physical characteristics: Red, turbid.
Microscopic: erythrocytes = >100 per HPF
(almost all dysmorphic)
Red cell casts present.

Questions:

- What is the most likely diagnosis in this case?
- Does the presence of red cell casts help you in any way?
- If the erythrocytes were not dysmorphic would that change your diagnosis?

Case 6

"Functional" proteinuria?
Microscopic may reveal a few leukocytes
Request protein concentration in 24 h urine

Glucose		Negative
Bilirubin		Negative
Ketones		Negative
S.G.		1.010
Blood		Negative
pH		5.0
Protein		+
Urobilinogen		0.2 mg/dL
Nitrite		Negative
L.E.		Negative

22-year old man presenting for a routine physical required for admission to medical school

Physical characteristics: Yellow
Microscopic: Not performed

Questions:

- What is your differential diagnosis?
- Would you order a microscopic analysis on this sample?
- What would you do next to confirm the diagnosis?

Common Findings in: Acute Tubular Necrosis

Glucose		
Bilirubin		
Ketones		
S.G.		Decreased
Blood		+ / -
pH		
Protein		+ / -
Urobilinogen		
Nitrite		
L.E.		

Microscopic:

- Renal tubular epithelial cells
- Pathological casts

Common Findings in: Acute Glomerulonephritis

Glucose		
Bilirubin		
Ketones		
S.G.		
Blood		Increased
pH		
Protein		Increased
Urobilinogen		
Nitrite		
L.E.		

Microscopic:

- Erythrocytes (dysmorphic)
- Erythrocyte casts
- Mixed cellular casts

Common Findings in: Chronic Glomerulonephritis

Glucose		
Bilirubin		
Ketones		
S.G.		Decreased
Blood		Increased
pH		
Protein		Increased
Urobilinogen		
Nitrite		
L.E.		

Microscopic:

- Pathological casts
(broad waxy casts, RBCs)

Common Findings in: Nephrotic Syndrome

Glucose	Green	
Bilirubin	Yellow	
Ketones	Orange	
S.G.	Dark Green	
Blood	Yellow	
pH	Orange	
Protein	Yellow	++++
Urobilinogen	Orange	
Nitrite	Yellow	
L.E.	Yellow	

Microscopic:

- Oval fat bodies
- Fatty casts
- Waxy casts

Common Findings in: Urothelial Carcinoma

Glucose	Green	
Bilirubin	Yellow	
Ketones	Orange	
S.G.	Dark Green	
Blood	Yellow	+
pH	Orange	
Protein	Yellow	
Urobilinogen	Orange	
Nitrite	Yellow	
L.E.	Yellow	

Microscopic:

- Malignant cells on urine cytology (urine sample should be submitted separately to cytology, void or 24 hrs.)

CASE #1

An 18-year-old, male high school student who had a 4-year history of diabetes mellitus was brought to the emergency department because of excessive drowsiness, vomiting, and diarrhea. His diabetes had been well controlled with 40 units of NPH insulin daily until several days ago, when he developed excessive thirst and polyuria. For the past 3 days, he has also had headaches, myalgia, and a low-grade fever. Diarrhea and vomiting began 1 day ago.

URINALYSIS RESULTS		CHEMISTRY TEST RESULTS	
Specific gravity	1.012	Sodium	126 mEq/L
pH	5.0	Potassium	6.1 mEq/L
Glucose	4+	Chloride	87 mEq/L
Ketone	Large	Bicarbonate	6 mEq/L
		Plasma glucose	600 mg/dL
		BUN	48 mg/dL
		Creatinine	2.0 mg/dL
		Serum ketones	4+

Questions

1. What is the probable diagnosis of this patient based on the data presented?
2. What laboratory test(s) should be performed to follow this patient and aid in adjusting insulin levels?
3. Why are the urine ketones positive?

CASE #2

A 58-year-old, obese man with frequent urination is seen by his primary care physician. The following laboratory work was performed, and the following results were obtained:

CASUAL PLASMA GLUCOSE 225 mg/dL	
URINALYSIS RESULTS:	
Color and appearance	Pale/clear
Blood	Negative
pH	6.0
Bilirubin	Negative
Specific	1.025
Glucose	2+
Nitrites	Negative
Ketones	Negative
Leukocyte esterase	Negative

Questions

1. What is the probable diagnosis of this patient?
2. What other test(s) should be performed to confirm this? Which is the preferred test?
3. After diagnosis, what test(s) should be performed to monitor his condition?

CASE #3

A 14-year-old, male student was seen by his physician. His chief complaints were fatigue, weight loss, and increases in appetite, thirst, and frequency of urination. For the past 3 to 4 weeks, he had been excessively thirsty and had to urinate every few hours. He began to get up 3 to 4 times a night to urinate. The patient has a family history of diabetes mellitus.

LABORATORY DATA		
Fasting Plasma Glucose	160 mg/dL	
Urinalysis:	Specific gravity	1.040
	Glucose	4+
	Ketones	Moderate

Questions

1. Based on the preceding information, can this patient be diagnosed with diabetes?
2. What further tests might be performed to confirm the diagnosis?
3. Assuming this patient has diabetes, which type would be diagnosed?

Group 7

CASE #4

A 13-year-old girl collapsed on a playground at school. When her mother was contacted, she mentioned that her daughter had been losing weight and making frequent trips to the bathroom in the night. The emergency squad noticed a fruity breath. On entrance to the emergency department, her vital signs were as follows:

Blood pressure	98/50 mm Hg
Respirations	Rapid
Temperature	99 F

Stat lab results included:

RANDOM URINE		SERUM CHEMISTRIES	
pH	5.5	Glucose	500 mg/dL
Protein	Negative	Ketones	Positive
Glucose	4+	BUN	6 mg/dL
Ketones	Moderate	Creatinine	0.4 mg/dL
Blood	Negative		

Questions

1. Identify this patient's most likely type of diabetes.
2. Based on your identification, circle the common characteristics associated with that type of diabetes in the case study above.
3. What is the cause of the fruity breath?

CASE #5

A 28-year-old woman delivered a 9.5-lb infant. The infant was above the 95th percentile for weight and length. The mother's history was incomplete; she claimed to have had no medical care through her pregnancy. Shortly after birth, the infant became lethargic and flaccid. A whole blood glucose and ionized calcium were performed in the nursery with the following results:

Whole blood glucose	25 mg/dL
Ionized calcium	4.9 mg/dL
Plasma glucose was drawn and analyzed in the main laboratory to confirm the whole blood findings.	
Plasma glucose	33 mg/dL
An intravenous glucose solution was started and whole blood glucose was measured hourly.	

Questions

1. Give the possible explanation for the infant's large birth weight and size.
2. If the mother was a gestational diabetic, why was her baby hypoglycemic?
3. Why was there a discrepancy between the whole blood glucose concentration and the plasma glucose concentration?
4. If the mother had been monitored during pregnancy, what laboratory tests should have been performed and what criteria would have indicated that she had gestational diabetes?

CASE #6

For 3 consecutive months, a fasting glucose and glycosylated hemoglobin were performed on a patient.

The results are as follows:

	QUARTER 1	QUARTER 2	QUARTER 3
Plasma glucose, fasting	280 mg/dL	85 mg/dL	91 mg/dL
Glycosylated hemoglobin	7.8%	15.3%	8.5%

Questions

1. In which quarter was the patient's glucose the best controlled? The least controlled?

CASE #7

A nurse caring for patients with diabetes performed a fingerstick glucose test on the Accu-Chek glucose monitor and obtained a value of 200 mg/dL. A plasma sample, collected at the same time by a phlebotomist and performed by the laboratory, resulted in a glucose value of 225 mg/dL.

Questions

1. Are these two results significantly different?
2. Explain.

CASE #8

A 52-year-old man went to his physician for a physical examination. The patient had been a district manager for an automobile insurance company for the past 10 years and was 24 pounds overweight. He had missed his last two appointments with the physician because of business. The urinalysis dipstick finding was not remarkable. His blood pressure was elevated. The blood chemistry results are listed below.

ANALYTE	PATIENT VALUE	REFERENCE RANGE
Na	151	135-143 mEq/L
K	4.5	3.0-5.0 mEq/L
Cl	106	98-103 mEq/L
CO ₂ content	13	22-27 mmol/L
Total protein	5.7	6.5-8.0 g/dL
Albumin	1.6	3.5-5.0 g/dL
Ca ²⁺	7.9	9.0-10.5 mg/dL
Cholesterol	210	140-200 mg/dL
Uric acid	6.2	3.5-7.9 mg/dL
Creatinine	2.5	0.5-1.2 mg/dL
BUN	95	7-25 mg/dL
Glucose	88	75-105 mg/dL
Total bilirubin	1.2	0.2-1.0 mg/dL
Alkaline phosphatase	27	7-59 IU/L
Lactate dehydrogenase	202	90-190 iu/l
Aspartate Transaminase	39	8-40 IU/L
Amylase	152	76-375 IU/L

Questions

1. Given the abnormal tests, what additional information would you like to have?
2. If this patient had triglycerides of 100 mg/dL (1.1 mmol/L) and an HDL cholesterol of 23 mg/dL (0.6 mmol/L), what would be his calculated LDL cholesterol value?
3. If, however, his triglycerides were 476 mg/dL (5.4 mmol/L), with an HDL cholesterol of 23 mg/dL (0.6 mmol/L), what would be his calculated LDL cholesterol value?

CASE #9

A 60-year-old woman came to her physician because she was having problems with urination. Her previous history included hypertension and episodes of edema. The physician ordered various laboratory tests on blood drawn in his office. The results are shown below.

ANALYTE	PATIENT VALUE	REFERENCE RANGE
Na	149	135-143 mEq/L
K	4.5	3.0-5.0 mEq/L
Cl	120	98-103 mEq/L
CO ₂ content	12	22-27 mmol/L
Total protein	5.7	6.5-8.0 g/dL
Albumin	2.3	3.5-5.0 g/dL
Ca ²⁺	7.6	9.0-10.5 mg/dL
Cholesterol	201	140-200 mg/dL
Uric acid	15.4	3.5-7.9 mg/dL
Creatinine	4.5	0.5-1.2 mg/dL
BUN	87	7-25 mg/dL
Glucose	88	75-105 mg/dL
Total bilirubin	1.3	0.2-1.0 mg/dL
Triglycerides	327	150 – 200 mg/dL
Lactate dehydrogenase	200	90-190 iu/l
Aspartate Transaminase	45	8-40 IU/L
Amylase	380	76-375 IU/L

Questions

1. What are the abnormal results in this case?
2. Why do you think the triglycerides are abnormal?

CASE #10

Three patients are seen in clinic:

- Patient 1 is a 40-year-old man with hypertension, who also smokes, but has not been previously diagnosed with CHD. His father developed CHD at age 53 years. He is fasting, and the results of his lipids include a total cholesterol concentration of 210mg/dL, triglycerides of 150 mg/dL, and an HDL cholesterol value of 45 mg/dL. He has a fasting glucose level of 98 mg/dL.
- Patient 2 is a 60-year-old woman with no family history of CHD, who is normotensive and does not smoke, with a total cholesterol concentration of 220 mg/dL, triglycerides of 85 mg/dL, and an HDL cholesterol value of 80 mg/dL. Her fasting glucose level is 85 mg/dL.
- Patient 3 is a 49-year-old man with no personal or family history of CHD, and who is not hypertensive and does not smoke. His fasting total cholesterol level is 260 mg/dL, his triglycerides are 505 mg/dL, his HDL cholesterol is 25 mg/dL, and his glucose level is 134 mg/dL.

Questions

For each patient seen in clinic:

1. What is the LDL cholesterol level, as calculated using the Friedewald calculation?
2. Which patient, if any, should have his or her LDL cholesterol measured, rather than calculated? Why?
3. How many known CHD risk factors does each patient have?